Spiders and harvestmen on tree trunks obtained by three sampling methods

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Abstract. We studied spiders and harvestmen on tree trunks using three sampling methods. In 2013, spider and harvestman research was conducted on the trunks of selected species of deciduous trees (linden, oak, maple) in the town of Přerov and a surrounding floodplain forest near the Bečva River in the Czech Republic. Three methods were used to collect arachnids (pitfall traps with a conservation fluid, sticky traps and cardboard pocket traps). Overall, 1862 spiders and 864 harvestmen were trapped, represented by 56 spider species belonging to 15 families and seven harvestman species belonging to one family. The most effective method for collecting spider specimens was a modified pitfall trap method, and in autumn (September to October) a cardboard band method. The results suggest a high number of spiders overwintering on the tree bark. The highest species diversity of spiders was found in pitfall traps, evaluated as the most effective method for collecting harvestmen too.

Keywords: Araneae, arboreal, bark traps, Czech Republic, modified pitfall traps, Opiliones

Trees provide important microhabitats for arachnids including specific microclimatic and structural conditions in the bark cracks and hollows (Wunderlich 1982, Nikolai 1986). Some species lives on tree trunks throughout the year, whereas other spiders use trees only for a certain period, mainly during overwintering (Horváth et al. 2001, 2004). Facultative bark-dwelling spiders which usually live in the canopies are found on trees only in late autumn to early spring, i.e. in season when deciduous trees are without leaves (Horváth & Szinetár 2002).

Bark-dwelling spiders are relatively rarely studied. Information on bark-dwelling spiders are scattered in studies focused on the diversity of fauna of particular forest habitats (e.g. Weiss 1995, Horváth & Szinetár 2002, Blick 2011) or parks and towns (e.g. Hansen 1992, Horváth & Szinetár 1998). Applied research may study bark-dwelling spiders as pest-control agents in orchards (e.g., Bogya et al.1999, Pekár 1999). Some studies are focused specifically on spider biology, e.g. overwintering (Pekár 1999, Spitzer et al. 2010) or habitat stratification (e. g. Simon 1994). Several species find shelter on tree trunks during harsh conditions, e.g. floods (Zulka 1989, Marx et al. 2012). In Europe, several hundreds of spider species were reported on the bark of different tree species (Szinetár & Horváth 2006, Blick 2011).

Different methods can be used to collect arachnids living on tree trunks. The most popular ones are arboreal eclectors placed on trunks (e.g. Albrecht 1995, Kubcová & Schlaghamerský 2002, Blick 2011) or branches in canopies (e.g. Koponen 2004, Moeed & Meads 1983, Simon 1995). Another method is the bark trap which can be made from wrapped cardboard (e.g. Bogya et al. 1999, Horváth & Szinetár 1998, 2002, Horváth et al. 2001, 2004, 2005) or polyethylene bubble film (Isaia et al. 2006). Pitfall traps (i.e. Barber traps) were adopted to sample trunk inhabiting invertebrates too (e.g. Pinzon & Spence 2008). Canopy-inhabiting invertebrates can be sampled by fogging (e.g. Otto & Floren 2007), window traps, various types of eclectors or direct beating of branches (Bolzern & Hänggi 2005, Blick & Gossner 2006, Aguilar 2010), but these methods are expensive, time-consuming or difficult.

This study is focused on the comparison of the species spectrum of spiders and harvestmen obtained by three simple low-cost trap designs – modified pitfall traps, cardboard bands and sticky traps.

Material and methods

The study was carried out in Přerov Town (49°26'58"N, 17°27'23"E) and a surrounding floodplain forest fragment (49°28'8"N, 17°29'7"E) in the Czech Republic. Both localities are situated at 220 m a.s.l. Spiders and harvestmen were sampled on the trunks of three different species of deciduous trees (Littleleaf linden – *Tilia cordata*, Norway maple – *Acer platanoides*, English oak – *Quercus robur*) using three different methods. Simple pitfall traps were made from the 1.5-litre plastic bottles (Fig. 1) filled with 0.25 litre of a saturated solution of salt (NaCl). Sticky traps were made from ordinary transparent sticky tape 20 cm wide and 40 cm long covered with a layer of glue 95-10-0220 used against tree pests (tape Stromset made by Propher, Fig. 2). Cardboard bands were made from corrugated cardboard 20 cm wide and 40 cm long (Fig. 3). Altogether, 90 traps were installed on 90 trees (each tree with one trap, 15 traps for each method in the forest as well as in the town, i.e. 45 trees in the forest and 45 trees in the town). The tree species were equally sampled by different traps in the forest and in the town (15 lindens, 15 maples and 15 oaks in both forest and town). Traps were placed on the tree trunks at a height of 4 m. Traps were exposed from May 5th to October 27th 2013 and sampled monthly. Spiders and harvestmen were identified to species level using common identification keys (Miller 1971, Šilhavý 1971, Nentwig et al. 2015). Nomenclature followes the World Spider Catalog (2015) and Martens (2013).

Results

Overall, 1862 spiders and 864 harvestmen were trapped, representing 56 spider species from 15 families and seven harvestman species from one family (Tab. 1). One third of all spiders were immature specimens (*Clubiona* 57 %, *Theridion* 23 %, *Philodromus* 20 %). Juveniles of Linyphiidae, which could not be determined to genus level, were not counted. Although the number of recorded individuals was higher in the forest than in town, the number of species was similar between the localities (39 vs. 39 species of spiders and seven vs. five harvestman species respectively). The highest number of species and specimens of spiders and harvestmen were found on oak. A total of 1133 spiders belonging to 48 species and

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Fig. 1: Pitfall trap made from a plastic bottle
Fig. 2: Sticky trap
Fig. 3: Cardboard band trap

805 harvestmen belonging to seven species were captured in modified pitfall traps. In total 16 spider species were recorded by pitfall trapping exclusively (30 % of all species sampled by this method). The most abundant taxa obtained using this method were *Anyphaena accentuata*, *Clubiona pallidula* (*Clubiona* sp.), *Drapetisca socialis* and the harvestman *Rilaena triangularis*. A total of 560 spiders belonging to 31 species but only 27 (mainly immature) harvestmen were sampled by cardboard bands (Tab. 1). Four spider species were obtained by this method exclusively (13 % of all species recorded by this method). The most abundant taxa obtained using this method were *Clubiona pallidula* and *Nuctenea umbratica*. A total of 169 spiders belonging to 24 species and 32 harvestmen belonging to three species were stuck on sticky traps. Three spider species were sampled by sticky traps exclusively (11 % of all species captured by this method). The most abundant taxa obtained with this method were *Philodromus* sp. and *Drapetisca socialis*. The number of spider and harvestman specimens trapped in pitfall traps was the highest in May at both localities (Fig. 4), whereas the number of species was the highest in July (Fig. 5). The effectivity of cardboard bands (both in the number of individuals and species) was highest in October (Figs 4, 5). Only 11 species of spiders were trapped by all methods, other species were recorded by one method exclusively, or by a combination of two methods (Tab. 1).

Discussion

The 56 spider species collected during this study mostly represent common arboreal species. The number of spider species is low in comparison with some other methods like eclectors (e.g. Albert 1976, Platen 1985, Simon 1995, Koponen 1996, Blick 2009, 2012). Evidently, trunk eclectors are much more effective in sampling the whole spider species spectrum compared to our methods. Using trunk eclectors in different forests in Germany Blick (2011) found a total of 334 spider species between 1990 and 2003. In a different project (Blick

Tab. 1: List of all collected spiders and harvestmen species and the number of specimens collected at two localities and by three different methods. L – linden, O – oak, M – maple; PT – pitfall traps, CB – cardboard bands, ST – sticky traps. Bold numbers indicate trapping exclusively with one method.

Species/Family	Locality		Tree			Method		
	Forest	Town	L	O	M	PT	CB	ST
Araneae								
Segestriidae								
Segestria senoculata (Linnaeus, 1758)	1	3	.	3	1	3	1	.
Mimetidae								
Ero furcata (Villers, 1789)	1	.	.	1	.	**1**	.	.
Theridiidae								
Anelosimus vittatus (C. L. Koch, 1836)	2	12	9	.	5	13	1	.
Dipoena melanogaster (C. L. Koch, 1837)	4	4	.	8	.	4	3	1
Enoplognatha ovata (Clerck, 1757)	12	2	3	9	2	10	.	4
Parasteatoda lunata (Clerck, 1757)	8	7	6	3	6	12	3	.
Parasteatoda simulans (Thorell, 1875)	.	1	1	.	.	.	.	**1**
Platnickina tincta (Walckenaer, 1802)	24	23	10	31	6	10	24	13
Steatoda bipunctata (Linnaeus, 1758)	.	2	.	2	.	.	**2**	.
Theridion mystaceum L. Koch, 1870	22	14	9	21	6	.	29	7
Theridion varians Hahn, 1833	4	10	6	7	1	9	1	4
Theridion sp. (juv.)	61	42	40	46	17	50	17	36
Linyphiidae								
Agyneta innotabilis (O. P.-Cambridge, 1863)	.	11	.	7	4	9	.	2
Agyneta rurestris (C. L. Koch, 1836)	7	2	5	4	.	7	1	1
Bathyphantes sp. (juv.)	1	.	.	1	.	**1**	.	.
Drapetisca socialis (Sundevall, 1833)	95	24	69	21	29	99	4	16
Entelecara acuminata (Wider, 1834)	13	12	7	2	16	22	.	3
Erigone atra Blackwall, 1833	.	1	1	.	.	.	.	**1**
Hypomma cornutum (Blackwall, 1833)	12	.	.	12	.	7	5	.
Lepthyphantes minutus (Blackwall, 1833)	80	15	17	39	39	53	42	.
Moebelia penicillata (Westring, 1851)	24	20	20	12	12	10	34	.
Neriene montana (Clerck, 1757)	13	.	.	13	.	2	11	.

Species/Family	Locality		Tree			Method		
	Forest	Town	L	O	M	PT	CB	ST
Tenuiphantes flavipes (Blackwall, 1854)	2	2	.	2	2	3	.	1
Trematocephalus cristatus (Wider, 1834)	8	6	4	2	8	11	1	2
Tetragnathidae								
Pachygnatha listeri Sundevall, 1830	1	.	.	1	.	**1**	.	.
Tetragnatha pinicola L. Koch, 1870	4	2	1	5	.	2	.	4
Araneidae								
Araneus sp. (juv.)	.	8	.	.	8	6	.	2
Gibbaranea gibbosa (Walckenaer, 1802)	.	3	3	.	.	**3**	.	.
Larinioides sclopetarius (Clerck, 1757)	.	4	4	.	.	**4**	.	.
Nuctenea umbratica (Clerck, 1757)	24	45	8	30	31	20	49	
Zygiella atrica (C. L. Koch, 1845)	.	1	.	.	1	**1**	.	.
Agelenidae								
Agelena labyrinthica (Clerck, 1757)	.	1	.	.	1	.	**1**	.
Eratigena atrica (C. L. Koch, 1843)		1	1	.	.	**1**	.	.
Tegenaria silvestris (L. Koch, 1872)	5	.	.	3	2	4	.	1
Dictynidae								
Brigittea civica (Lucas, 1850)	.	2	2	.	.	1	.	1
Dictyna uncinata Thorell, 1856	1	.	1	.	.	.	.	1
Emblyna annulipes (Blackwall, 1846)	.	2	.	.	2	.	**2**	.
Lathys humilis (Blackwall, 1855)	4	.	.	3	1	3	1	.
Nigma flavescens (Walckenaer, 1830)	2	.	.	2	.	1	.	1
Nigma walckenaeri (Roewer, 1951)	.	10	.	.	10	2	8	.
Euticluridae								
Cheiracanthium mildei L. Koch, 1864	.	10	1	.	9	5	5	.
Anyphaenidae								
Anyphaena accentuata (Walckenaer, 1802)	241	114	78	214	73	316	33	6
Clubionidae								
Clubiona brevipes Blackwall, 1841	8	.	.	8	.	**8**	.	.
Clubiona comta C. L. Koch, 1839	3	.	1	2	.	2	**1**	.
Clubiona lutescens Westring, 1851	.	3	2	.	1	2	1	.
Clubiona pallidula (Clerck, 1757)	175	124	62	184	53	105	191	3
Clubiona sp. (juv.)	202	54	68	114	74	175	51	30
Gnaphosidae								
Micaria subopaca Westring, 1861	3	.	.	3	.	2	1	.
Philodromidae								
Philodromus albidus Kulczyński, 1911	1	13	10	.	4	10	1	3
Philodromus sp. (juv.)	23	47	17	31	22	53	.	17
Thomisidae								
Ozyptila praticola (C. L. Koch, 1837)	36	4	.	40	.	11	29	.
Pistius truncatus (Pallas, 1772)	5	.	1	4	.	.	5	.
Synema globosum (Fabricius, 1775)	1	.	.	1	.	**1**	.	.
Xysticus lanio C. L. Koch, 1835	18	.	2	12	4	**18**	.	.
Salticidae								
Ballus chalybeius (Walckenaer, 1802)	8	5	3	10	.	**13**	.	.
Evarcha falcata (Clerck, 1757)	1	.	.	1	.	**1**	.	.
Salticus scenicus (Clerck, 1757)	.	8	5	.	3	**8**	.	.
Salticus zebraneus (C. L. Koch, 1837)	9	19	7	17	4	18	4	6
Opiliones								
Phalangiidae								
Lacinius dentiger (C. L. Koch, 1847)	3	1	.	2	2	**4**	.	.
Lacinius ephippiatus (C. L. Koch, 1935)	17	6	.	11	12	**23**	.	.
Mitopus morio (Fabricius, 1799)	1	.	.	.	1	**1**	.	.
Opilio canestrinii (Thorell, 1876)	7	20	5	12	10	26	1	.
Opilio saxatilis C. L. Koch, 1839	3	.	3	.	.	1	.	2
Phalangiidae spp. (juv.)	26	.	.	26	.	.	**26**	.
Phalangium opilio Linnaeus, 1761	12	1	4	7	2	9	.	3
Rilaena triangularis (Herbst, 1799)	566	202	203	471	94	741	.	27

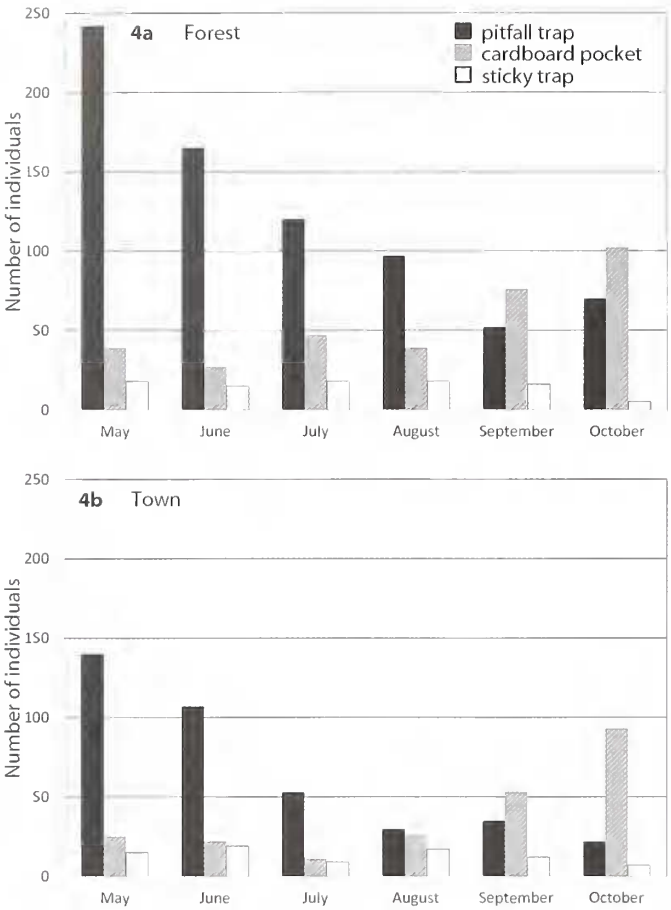

Fig. 4: Number of spider specimens obtained by three sampling methods during one year (total number); above (**4a**) – forest, below (**4b**) – town

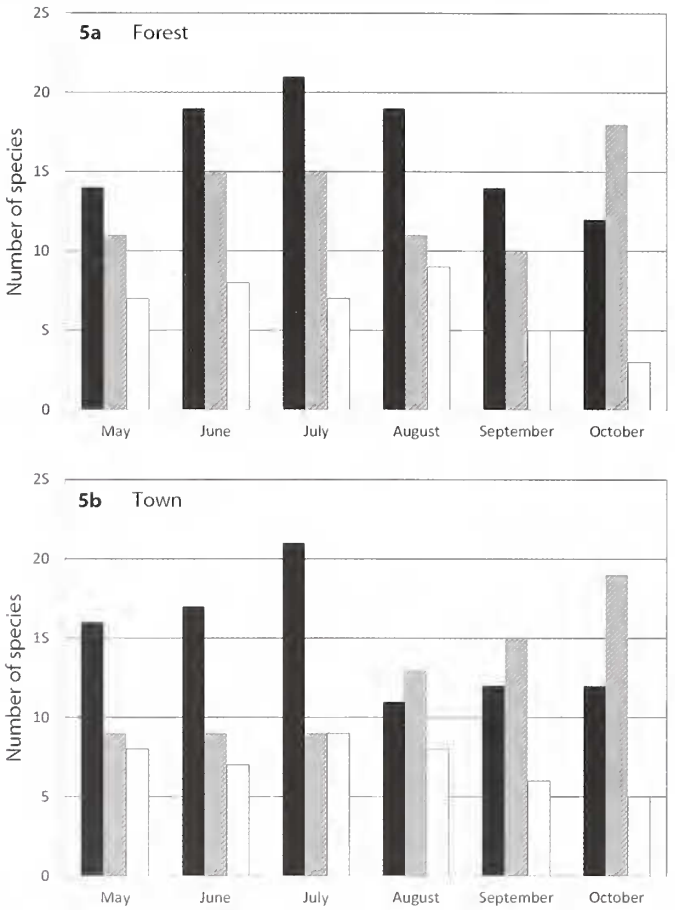

Fig 5: Number of spider species obtained from three sampling methods during one year (total number); above (**5a**) – forest, below (**5b**) – town

2010), 105-151 spider species was sampled using just 8 eclectors in different forest reserves in Hesse (Germany). Similarly, Platen (1985) sampled 69 species using just one eclector.

Nevertheless, in comparison with other studies using modified pitfall traps, its efficiency was similar: Weiss (1995) found 57 species and Machač (2014) found 33 spider species and 3 harvestman species from 18 traps contrary to 48 species recorded by pitfall traps in this study. We trapped relatively more harvestman species than has been published (Sührig & Rothländer 2006), but without some typical bark-dwelling species, e.g. from the genus *Leiobunum*. The number of species can also be influenced by the type of locality, both localities are relatively disturbed and without protected nature status.

Most of the collected spider species in the forest are widespread, silvicolous spiders with a known arboreal occurrence (Szinetár & Horváth 2006). In the town, synanthropic species of spiders were collected too, e.g. *Brigittea civica*, *Cheiracanthium mildei* and *Nigma walckenaeri* (Buchar & Růžička 2002). The most dominant species found in the town and the forest are the common spider species *Anyphaena accentuata*, *Clubiona pallidula* and the harvestman *Rilaena triangularis*, known from previous studies (e.g. Horváth et al. 2001, Horváth & Szinetár 2002). The greatest number of spider specimens collected using cardboard bands were obtained during September and October (almost 60% of them). The exclusive species recorded in cardboard bands were *Agelena labyrinthica*, *Emblyna annulipes*, *Pistius truncatus* and *Steatoda bipunctata*. Tree trunks provide important shelters for the overwintering of spiders (Pekár 1999, Horváth & Szinetár 2002, Szinetár & Horváth 2006). Corrugated cardboard bands simulate tree bark asperities and spiders used them preferably (Isaia et al. 2006). During summer months, these cardboard bands are inhabited mostly by females with egg sacs, e.g. *Clubiona pallidula*, *Nuctenea umbratica* or *Ozyptila praticola*, which provide calm and warm shelters. Similarly, the spider *Oreonetides quadridentatus* is known to migrate onto tree trunks from soil during spring (Kopecký & Tuf 2013). Cardboard bands seem to be effective for sampling species living under bark or overwintering on trunks. On the contrary, this method is not suitable for harvestmen as only one aggregation of unidentified juveniles was found.

The pitfall traps made from PET bottles obtained the most spider specimens and the largest number of spider species (48) as well as harvestmen species (seven). Also, the highest portion of exclusive species was recorded by this method, including a majority of specimens belonging to Araneidae and Salticidae as well as harvestmen. The highest number of spider and harvestman specimens was obtained by this method during May, including the harvestman *Rilaena triangularis* which is most active in this month (Klimeš 1990). Pinzon & Spence (2008) found only 33 species on trunks using trunk pitfall traps in the forests of Canada. Trunk pitfall traps are, however, very effective for sampling of spiders and harvestmen living on tree trunks (Weiss 1995).

The sticky trap method was not effective for arachnids at all. Twenty-four spider (mostly juveniles and small species) and three harvestman species were obtained using this method only. Moreover, harvestmen were usually damaged when

releasing them from the glue. This method is not usually used for sampling arachnids, but is suitable for monitoring ballooning spiders (e.g. Greenstone et al. 1985). Sticky traps are more suitable for flying insects, e.g. Coleoptera, Diptera or Hymenoptera (Horváth et al. 2005, Bar-Ness et al. 2012).

Based on our results, we can recommend pitfall trapping for sampling spiders and harvestmen from tree trunks. In autumn and during winter, this method can be combined (or replaced) with cardboard bands (bark traps) as an effective method to collect arachnids searching for overwintering shelters.

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